GEOLOGY OF THE NOTAKWANON RIVER AREA, LABRADOR

by

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INTRODUCTION

This report gives the preliminary results of the fourth year of a regional bedrock mapping project in the Davis Inlet - Mistastin Lake corridor. The area mapped in 1980 comprises four 1:50,000 scale N.T.S. map sheets (13M/9, 13M/10, 13M/15, 13M/16). It is bordered on the east by the Flowers River area (Hill, in preparation) and on the west by the Mistastin Lake area, currently being mapped by R.F. Emslie of the Geological Survey of Canada.

The eastern part is mainly underlain by undeformed igneous intrusive rocks and is marked by numerous rugged hills rising 300 to 500 m above the river valleys and lakes. Bedrock exposure is good and mapping was done by ground traverses supported by helicopter. To the west, the land is underlain by gneisses of the Churchill Structural Province and is characterized by low, rounded hills and extensive plains covered with glacial drift and sand. Bedrock exposure is sporadic and mapping was done mainly by helicopter along east-west flight lines spaced at 1.5 km intervals.

Previous geological work is limited to reconnaissance mapping by Brinex (Beavan, 1954) and the Geological Survey of Canada (Taylor, 1972, 1979). The map given here incorporates work done between 1977 and 1980 as well as the field data of Taylor (1972). Two areas remain unmapped because of inclement weather in the summer of 1980.

REGIONAL GEOLOGICAL SETTING

The area straddles the southwest margin of the Nain Igneous Complex with the Churchill Structural Province. The western and southern parts are underlain by a variety of supracrustal and plutonic gneisses which are believed to be Aphebian in age or older. They were deformed and metamorphosed during the Hudsonian Orogeny about 1700 Ma (Emslie, 1978). The amount of deformation within the gneisses is variable and sedimentary bedding and igneous plutonic textures can be recognized in places. Dikes and lenses of slightly deformed to undeformed leucogranite pegmatite and undeformed diabase dikes have intruded the gneisses locally.

The Nain Igneous Complex is a bimodal suite of granitic and anorthositic intrusions of Paleohelikian age. These rocks are undeformed except for isolated shear zones and were emplaced in an anorogenic environment. Numerous screens of Churchill gneiss are preserved between some of the plutons in the igneous complex.

DESCRIPTION OF UNITS

Churchill Structural Province

Unit 1: Amphibolite

Amphibolite occurs in several north to northwest trending belts up to 1 km thick. It is also present as thin layers in banded gneiss in Unit 2, and as blocks and bands in migmatite south of the 452 m lake.

The amphibolite consists mainly of plagioclase and amphibole with accessory amounts of clinopyroxene, epidote and opaques. Quartz is also present in some samples in trace amounts. Garnet has been reported in amphibolite farther north (Taylor, 1979) but was not identified in the current map area. The proportions of plagioclase and amphibole

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are variable and individual bands and outcrops may contain up to 100% amphibole.

The texture is typically fine to medium grained and schistose to finely banded. The banding tends to be streaky and discontinuous and is defined by alternations of plagioclase and mafic-rich lithologies. In places, the white-weathering feldspathic streaks also contain a few percent quartz. In some outcrops, the amphibolite is coarse grained and takes on a blotchy or tiger-stripe appearance, depending on the amount of strain present. Coarse grained to pegmatitic plagioclase-amphibole stringers trend parallel to the foliation in places and emphasize the fabric where they are present. Most of the occurrences of Unit 1 contain variable amounts of mylonitic to gneissic leucogranite (Unit 5). The leucogranite intrudes the amphibolite and the two lithologies form injection and banded migmatite where the proportion of leucogranite is large.

No primary structures were found preserved in the amphibolite. This feature led Taylor (1979) to suggest the unit may have been formed by the intrusion of gabbro sills. However, in 13M/15 and in 13N/12 (Hill, 1980), amphibolite is interlayered with felsic gneisses of highly uniform texture and composition and the rocks resemble a volcanic sequence.

Unit 2: Diorite to Tonalite Gneiss

A large variety of dioritic to tonalitic gneisses is included in Unit 2. At least four types can be recognized. These are diorite to quartz diorite gneiss, well banded tonalite gneiss, unbanded and mylonitic to streaky tonalite gneiss, and obvious paragneiss. These lithologies are commonly mixed together in alternating outcrops and are only locally subdivisible at map scale.

The diorite to quartz diorite gneiss is the dominant lithology in Unit 2 along the western boundary of the map area and is also present as bands and whole outcrops in Unit 2 farther east. It is fine to medium grained and finely banded to streaky. In a few outcrops, it is interbanded with amphibolite and tonalite gneiss and, in one place, contains blocks of amphibolite. Quartz generally varies between 0% and 15%. The mafic minerals are typically amphibole and biotite and amount to 20% to 35% of the rock.

Well banded tonalite gneiss underlies large parts of the central and southern areas included in Unit 2. It is typically medium grained and individual bands vary from 1 mm to 1 m thick. The bands range from amphibolite to granite in composition but tonalite is the most common type. The mafic minerals range from 5% to 20% on average and include biotite, amphibole, clinopyroxene, orthopyroxene and garnet. Quartz varies between 15% and 30% except in the most mafic bands, where it may be absent. Sillimanite was identified in only a few outcrops. Two outcrops of banded tonalite gneiss were observed which contain isolated inclusions of amphibolite similar to that in Unit 1.

The unbanded to streaky tonalite gneiss is mainly restricted to the northeast part of the Churchill gneiss terrain in 13M/15. It is fairly homogeneous in composition and texture except for scattered layers of amphibolite up to a few metres thick. The banding, where present, is defined by discontinuous streaks of slightly varying composition up to a few millimetres thick. In general, it is biotite tonalite in composition but locally appears to grade into granodiorite. Orthopyroxene was found in one sample. Microcline varies from 0% to 15%, quartz is 20% to 25%, and the mafic minerals are generally less than 12% of the rock.

LEGEND

PALEOHELIKIAN

Nain Igneous Complex

7	*Medium to coarse grained equigranular granite, quartz monzonite, fine grained aphyric granite, quartz-feldspar porphyry;* 7a, *medium grained monzonite, monzodiorite, diorite.*
6	*Coarse grained anorthosite and leucogabbro, minor fine grained olivine gabbro.*

APHEBIAN (OR OLDER)

Churchill Structural Province

5	5a, *Medium to coarse grained biotite metagranite with feldspar augen;* 5b, *Mylonitic, fine to medium grained biotite metagranite and metagranodiorite, locally gneissic.*
4	4a, *Coarse grained, megacrystic biotite-garnet metagranite to metatonalite;* 4b, *Mylonitic, fine to coarse grained biotite-garnet metagranite.*
3	*Medium to coarse grained meta-anorthosite.*
2	*Banded and mylonitic unbanded diorite, quartz diorite and tonalite gneiss, locally containing bands of granodiorite and granite gneiss.*
1	*Fine to medium grained amphibolite.*
	Migmatite consisting of mixed layers of units 1, 2, and 5.

SYMBOLS

Geologic boundary . . . .

Plagioclase lamination (dip > 30^o, dip < 30^o) . . . .

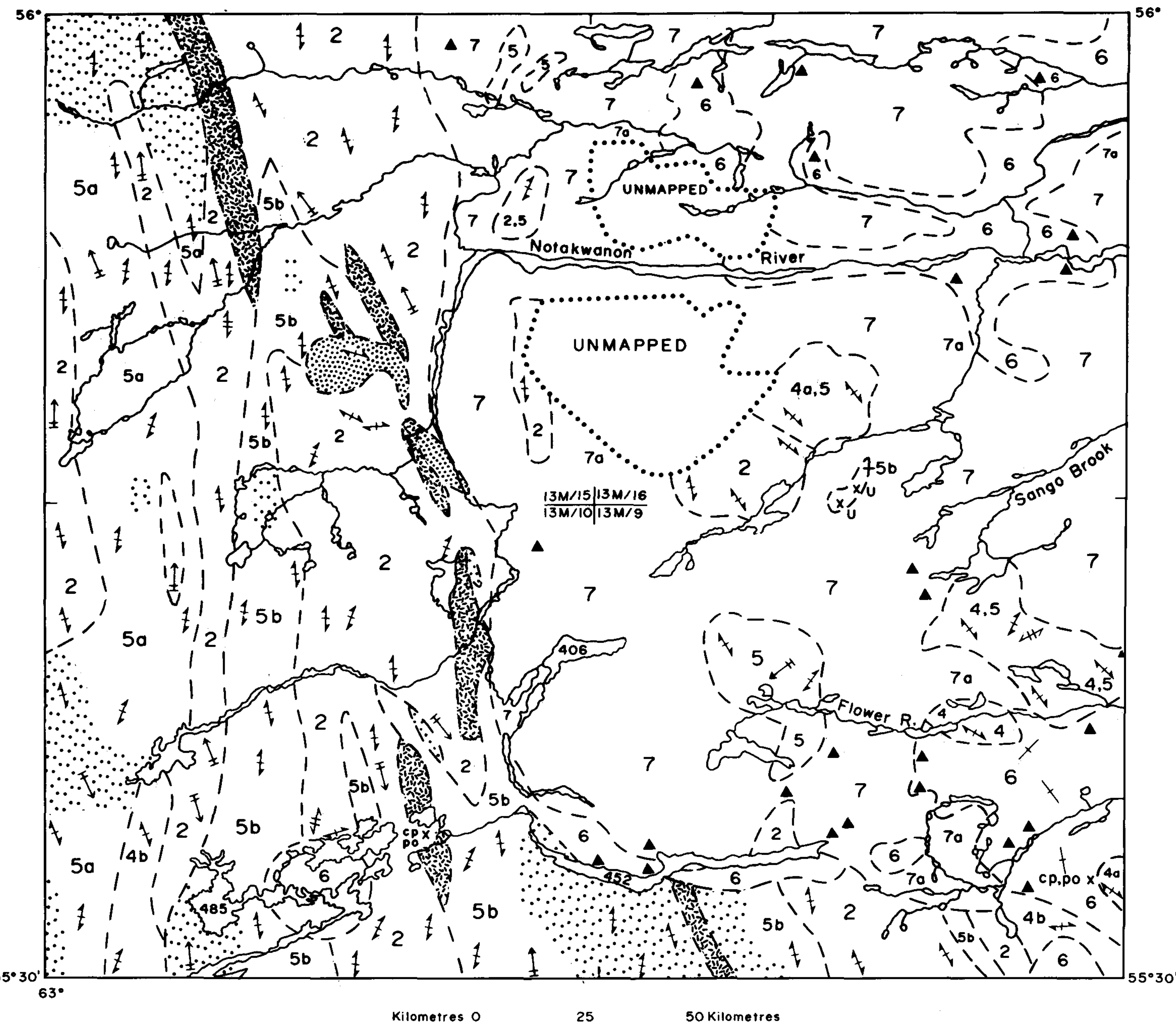
S_1 *gneissic banding, shistosity (dip > 30^o, dip < 30^o)* . . . .

S_2 *mylonitic foliation (dip > 30^o, dip < 30^o)* . . . .

F_2 *fold axis,* L_2 *mineral lineation (plunge < 30^o, plunge > 30^o)* . . . .

Agmatite . . . . ▲

Mineral occurrence (po - pyrrhotite; cp - chalcopyrite; U - uranium) x


56°
56°
55°30'
63°
55°30'
UNMAPPED
UNMAPPED
Notakwanon
River
Sango Brook
Flower R.
13M/15
13M/16
13M/10
13M/9
406
452
485
cp x
po
cp,po x
x/u
Kilometres 0
25
50 Kilometres

Obvious paragneiss occurs as isolated outcrops which could not be distinguished as a separate unit at map scale. These generally consist of banded tonalite to granodiorite gneiss and schist containing biotite, garnet and sillimanite. They are marked by bands enriched in graphite, pyrite or quartz. In addition, discontinuous lenses of marble were found in one outcrop of paraschist. The paragneiss and paraschist tend to be fine grained and compositionally layered. In places, the layering resembles relict bedding. All gradations between obvious paragneiss and the banded tonalite gneiss of uncertain origin described above were observed in the field.

All of the lithologies in Unit 2 are interbanded and crosscut by stringers of deformed and undeformed leucogranite. The deformed leucogranite resembles the rocks of Unit 5. The presence of inclusions of amphibolite in some outcrops of more homogeneous diorite to tonalite gneiss suggests that parts of Unit 2 may be intrusive in origin. The unbanded to streaky tonalite gneiss in 13M/15 is monotonous in texture and composition and is interlayered with amphibolite, suggesting that it may be volcanic in origin. At least some outcrops of the well banded tonalite gneiss must be sedimentary in origin since gradations with obvious paragneiss were recognized in the field.

Unit 3: Meta-anorthosite

Meta-anorthosite forms three small, elongate masses and one larger, more rounded body in 13M/15 and 13M/16. It is typically medium to coarse grained, white weathering and granoblastic. The mafic minerals are concentrated in streaks and layers up to 50 cm thick and the layers are commonly arranged in groups. Plagioclase ranges between 75% and 100% of the rock. The mafic minerals are mainly amphibole and biotite.

No contacts between Unit 3 and any other unit have been observed so its exact age is uncertain. However, the meta-anorthosite is folded and metamorphosed and must have been emplaced before the end of the Hudsonian Orogeny. The largest body appears to transect the stratigraphy of some of the gneisses to the north, suggesting that Unit 3 is younger than Units 1 and 2. Taylor (1979) has described similar meta-anorthosite which occurs farther north and which is crosscut by pegmatite dikes dated at 1530 Ma (K/Ar, biotite).

The mafic banding and overall composition of the meta-anorthosite suggest that it is intrusive in origin. Although meta-anorthosites of sedimentary origin have been recognized elsewhere (Hietanen, 1963), the alumino-silicate minerals characteristic of those bodies are lacking in Unit 3.

Unit 4: Biotite-garnet metatonalite to metagranite

Unit 4 forms only a small portion of the gneiss terrain in the current map area although it is more abundant farther east in 13N/12 (Hill, 1980). It is divided into a coarse grained, megacrystic phase (Unit 4a) and a finer grained, nonmegacrystic phase (Unit 4b). These rocks are similar in overall texture and composition to Unit 5 except that the latter lacks garnet.

The coarse grained phase (Unit 4a) is characterized by rounded megacrysts of quartz and feldspar up to 7 cm long. The megacrysts are aligned parallel to the foliation defined by a fine to medium grained schistose matrix. Where megacrysts are lacking, the rock tends to be more granoblastic and medium to coarse grained. The overall composition is tonalite to granite. Biotite and garnet are the dominant mafic minerals and amount to 5% to 20% of the rock. In addition, orthopyroxene was found in one specimen collected in the southeast corner of the map area.

The finer grained phase (Unit 4b) is white weathering and tends to have a mylonitic foliation. It locally contains crosscutting lenses and dikes of slightly deformed and undeformed biotite-garnet leucogranite pegmatite.

Unit 4b appears to be uniformly biotite-garnet granite in composition and mafic minerals tend to be less 10% of the rock.

The rocks of Unit 4 are uniform over large areas and gneissic banding tends to be lacking. However, changes in grain size, probably the result of strain variation, have produced a fine textural banding. In addition, inclusions and layers of Unit 2 are locally present in Unit 4 and give a banded appearance to the outcrop. The uniformity and granitoid textures of Unit 4 suggest it is intrusive in origin. The presence of inclusions of tonalite gneiss indicate it is younger than Unit 2. The relationship between Units 4a and 4b is uncertain. They may represent different ages of igneous activity or they may simply reflect textural variations in a single lithologic unit.

Unit 5: Biotite metagranodiorite, metagranite.

Leucocratic to mesocratic biotite metagranodiorite to metagranite forms a large part of the Churchill gneiss terrain. It is subdivided into a coarse grained, megacrystic phase (Unit 5a) and a fine to medium grained, mylonitic phase (Unit 5b). The two textural phases are separated at map scale but in places they coexist and may be gradational with each other.

The megacrystic phase (Unit 5a) is a foliate granite with augen of quartz and feldspar up to 10 cm long set in a fine to medium grained, schistose to granoblastic matrix of quartz, feldspar and minor biotite and amphibole. Quartz varies from 20% to 25% and the mafic minerals range from 5% to 15% of the rock, On average, the unit is texturally and compositionally uniform. In places, however, megacrysts are lacking and the rock is identical to Unit 5b. In some outcrops, the unit is faintly banded due to variations in texture and all gradations from fine grained, mylonitic granite to coarse grained, granoblastic and coarse grained, megacrystic granite may be present.

The mylonitic phase (Unit 5b) is typically homogeneous in composition and texture at outcrop scale. However, the rock is finely banded in places due to changes in grain size and the presence of lensoid, millimetre-thick compositional variations. In general, the unit is leucogranitic in composition but granodioritic and quartz monzonitic variations are present. Quartz ranges from 15% to 30%. The mafic minerals are mainly biotite and amphibole and range from 2% to 8% of the rock.

In places, Unit 5 contains bands and blocks of amphibolite and tonalite gneiss of Units 1 and 2. Where the proportions of mafic and felsic gneiss are approximately equal, the rocks are indicated as migmatite on the map (Figure 1). Typically, the migmatite is characterized by parallel bands of Units 1, 2 and 5 up to a few metres thick, but in some outcrops, the metagranite of Unit 5 crosscuts the mafic gneiss as dikes and injection migmatite is developed.

The relatively uniform composition and the local preservation of relict igneous plutonic textures in Unit 5 suggest it is intrusive in origin. The contrasting textures between Units 5a and 5b are believed to reflect, at least in part, predeformation differences modified by subsequent tectonism. However, in outcrops where the two textural phases are gradational and interbanded, the contrasting textures appear to reflect variations in tectonic strain. Dikes of Unit 5 crosscut rocks of Units 1 and 2. The contact relationships of Unit 5 with Units 3 and 4 were not observed.

Nain Igneous Complex

Unit 6: Gabbroid plutons

Several intrusions are exposed which contain undeformed rocks ranging from gabbro to anorthosite. In addition, isolated outcrops of anorthosite and leucogabbro are preserved within the granitoid rocks of Unit 7.

Plagioclase is the dominant mineral and typically ranges from 70% to 100% of the rock. It is generally close to An_{50} in composition but ranges to An_{69} in leucogabbro southeast of the 452 m lake. The plagioclase tends to occur as decussate to foliate subhedral laths which are unzoned. The main mafic minerals are olivine, clinopyroxene and opaques. However, olivine or clinopyroxene may be absent in some outcrops. Olivine occurs in two habits. The more common type is poikilitic and encloses plagioclase grains. However, in some outcrops, olivine occurs as equant subhedra lying between the plagioclase laths. Clinopyroxene is typically poikilitic and the opaques generally form wedge-shaped grains bounded by plagioclase laths.

Gabbro was only found as fine grained rock at the margins of two of the plutons. On the south shore of the 452 m lake, the gabbro is fine grained and massive and is in concordant contact with tonalite gneiss. The gabbro gradually becomes coarser grained and more leucocratic east of the contact and, 40 m from the contact, the rock is coarse grained leucogabbro with about 30% mafic minerals. On the north side of the lake, the contact relationships are obscured by lichen cover. However, medium grained leucogabbro occurs to within 1 m of the gneiss contact and no gabbro was recognized. In the southeast corner of the map area, another contact between gneiss and Unit 6 is exposed. Here, the gabbro is fine grained, highly altered and contains 1% plagioclase phenocrysts and numerous xenoliths of gneiss.

The gabbro-anorthosite plutons are correlated with similar intrusions farther east and north in the Nain Igneous Complex. Textures and structures in the Flowers River area indicate the plutons are cumulate in origin (Hill, in preparation) and a similar origin is interpreted for the Notakwanon River area.

The shapes of most of the plutons are unknown. The large gabbroid pluton in the northeast part of 13M/16 is only exposed in river valleys whereas Unit 7 is exposed on the surrounding hill tops. This suggests the contact between the gabbroid and granitoid rocks in that area is approximately horizontal. The relative age of the gabbroid plutons is indicated by the presence of monzonite and granite dikes of Unit 7 which cut leucogabbro and anorthosite in several places. One gabbroid pluton differs from the others in that it is highly altered and for this reason may be older than the gabbroid plutons of the Nain Igneous Complex. The pluton is poorly defined because of lack of outcrop and lies within the gneiss terrain east of the 452 m lake.

Unit 7: Granitoid plutons

Unit 7 includes a large variety of undeformed intrusive rocks which range from diorite to granite in composition. An older group consists of quartz-poor lithologies and includes diorite, monzodiorite and monzonite. The younger group includes granite, granodiorite, quartz monzonite and their fine grained and porphyritic equivalents. The two groups are locally difficult to distinguish in the field and have been mapped as a single unit until thin section data become available.

The quartz-poor granitoid rocks (Unit 7a) form several small plutons which lie between the gabbroid intrusions of Unit 6 and the granite of Unit 7. They range from diorite to monzonite due to variations in the proportions of potassium feldspar and plagioclase. Quartz is typically less than 10% and is absent in many outcrops. The dominant mafic minerals are amphibole, clinopyroxene and olivine but biotite and orthopyroxene are important constituents in some samples.

The quartz-rich granitoid rocks may be divided into two textural phases; namely, a suite of fine grained and porphyritic rocks and a suite of medium to coarse grained, equigranular rocks. Both phases are similar in composition and granite is the most abundant type. Quartz is generally 20% to 35% except in places north of the Notakwanon River in 13M/16, where quartz monzonite with only 10% to 15% quartz occurs. The relationship of the quartz monzonite with the more common granite is uncertain. The proportions of plagioclase and potassium feldspar are variable and the granite locally grades into granodiorite. The main mafic minerals are olivine, amphibole and clinopyroxene although biotite is present in some samples. The fine grained phase includes an aphyric variety and quartz-feldspar porphyry. These rocks are widely distributed throughout Unit 7 and occur exclusively associated with the amphibole-clinopyroxene-olivine granite and granodiorite (Figure 2). The fine grained phase is present as blocks and larger, undefined zones in the granite. The contacts between the two phases are typically intrusive and dikes of granite cut the fine grained phase in many places. However, at two localities, the fine grained phase grades into the coarse grained, equigranular granite over a few millimetres.

The low quartz plutons ranging from diorite to monzonite form an older group distinct from the quartz-rich granitoid rocks. Dikes of granite cut monzonite and diorite in several places. These rocks form a volumetrically minor suite of plutons intermediate in age and composition between the gabbroid and quartz-rich granitoid intrusions in the Nain Igneous Complex. The granite and related rocks represent the last period of intrusive activity in this part of the Nain Igneous Complex. The widespread association, similar composition, and local gradational contacts of the fine grained and coarse grained phases suggest the two varieties are genetically related. The fine grained phase may represent a foundered roof broken up and engulfed by the main body of rising granite magma. This idea is not supported by a Rb/Sr whole rock isochron for the granite in Unit 7. Two samples of quartz-feldspar porphyry fall off the line defined by six samples of coarse grained granite (Brooks, personal communication). The six granite samples give an age of 1217 $\pm$ 24 Ma with an initial ratio of 0.7101 $\pm$ 0.0009.

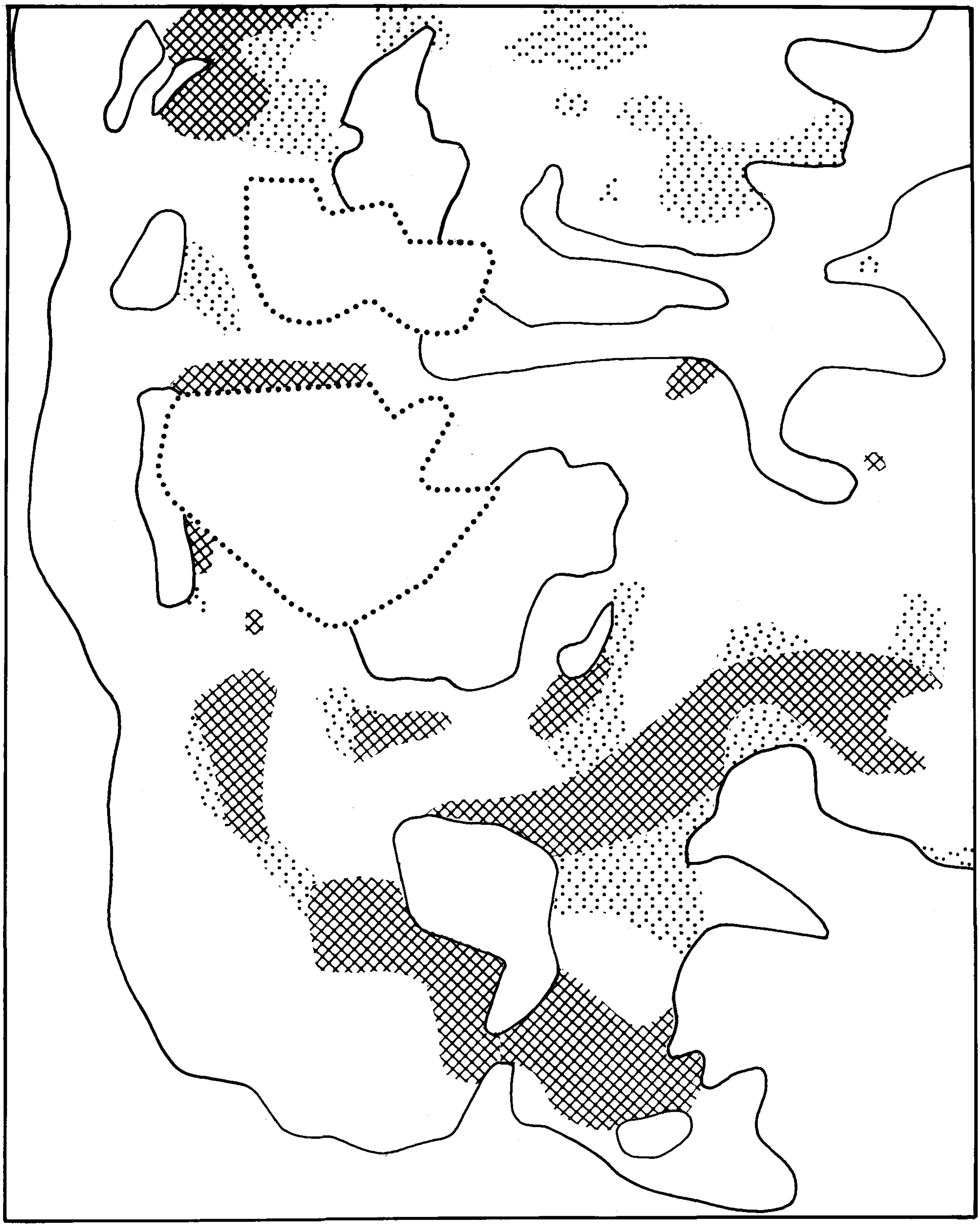
Diabase Dikes

Small, undeformed diabase dikes intrude both the Churchill gneisses and the Nain Igneous Complex. Several dikes up to a few metres thick were found in the gneisses oriented parallel to the gneissosity in the host rock. The diabase is fine to medium grained and hydrothermally altered, although primary plagioclase and clinopyroxene can still be recognized in thin section. Two diabase dikes, one unaltered and the other partly altered, were found crosscutting granite of Unit 7 in the Nain Igneous Complex. Both contain significant amounts of olivine in addition to plagioclase, clinopyroxene and opaques.

STRUCTURE AND METAMORPHISM

The Churchill gneisses and the intrusive rocks of the Nain Igneous Complex are separated in time and structure by the Hudsonian Orogeny which occurred about 1700 Ma (Emslie, 1978). This was the last period of penetrative deformation in the area and the intrusions of the Nain Igneous Complex appear to have been emplaced in an anorogenic environment.

Two phases of penetrative deformation have been recognized in the gneisses and are attributed to the Hudsonian Orogeny. The earliest phase (D_1) is represented by gneissic banding (S_1) which is best developed in Unit 2 and is sporadically developed in Units 1, 4 and 5. The banding in the meta-anorthosite of Unit 3 appears to be relict igneous layering which may or may not have been modified by D_1.



>40 %

5 to 40 %

Fine grained granite and quartz-feldspar porphyry

Figure 2 - Distribution of fine grained granite and quartz - feldspar porphyry in Unit 7.

Amphibolite grade metamorphic mineral assemblages are typically associated with S_1 as shown by the widespread occurrence of biotite, amphibole and clinopyroxene. Sillimanite is present in some parts of Unit 2. Garnet is common in Units 2 and 4 but it appears to have formed prior to S_1. Orthopyroxene is associated with S_1 in scattered outcrops of Unit 2 and may indicate regional granulite grade metamorphism during D_1.

A second phase of deformation (D_2) is shown by a mylonitic foliation (S_2) which is invariably oriented parallel to S_1 except at F_2 fold closures. The formation of S_2 appears to have been mainly cataclastic and ribbon quartz, mortar structure, granulation and broken grains are developed. However, in places, metamorphism appears to have been sufficient for the recrystallization of fine grained quartz, feldspar and biotite. Many outcrops are texturally banded on a centimetre to decimetre scale due to variations in grain size and degree of perfection of the mylonitic fabric. This appears to have been caused by variations in strain across strike during D_2. Mesoscopic folds (F_2) with subhorizontal plunges and upright axial planes are associated with S_2. A mineral lineation (L_2) with a subhorizontal plunge is also present and in some outcrops it is the dominant penetrative fabric preserved. Where L_2 is well developed and inclusions of more mafic material occur, the inclusions are rod shaped and are oriented parallel to the mineral lineation.

A third period of regional deformation may have affected the Churchill gneisses. S_1, S_2 and F_2 structures are deflected into a large S-sense flexure centered on a meta-anorthosite body northwest of the 406 m lake in 13M/15. An outcrop of granite gneiss immediately north of the meta-anorthosite has S-sense mesoscopic folds which plunge 40° at 340° while S_1 and F_2 in the same outcrop trend at 315°.

Isolated shear zones occur within single outcrops in both the gneisses and the Nain Igneous Complex. Zones of mylonite up to a few centimetres thick are developed in some of the shears. In the eastern part of the map area, the shears are oriented east-west and the movement was sinistral. They crosscut the Nain Igneous Complex as well as older gneisses farther east (Hill, in preparation). In the gneiss terrain in the western part of the area, the shears are oriented east-west to northeast-southwest and movement was dextral. These shears have not been recognized in any rocks younger than the Churchill gneisses.

The Nain Igneous Complex is marked by numerous major topographic lineaments. Significant fault movement along these lineaments has not been recognized in the map area. However, outcrops in the valleys of some of the lineaments are marked by fractures, hydrothermal alteration and quartz veins. In addition, brecciation was found in fracture planes in one outcrop.

ECONOMIC GEOLOGY

Mineral showings are present in both the Churchill gneisses and the Nain Igneous Complex. The most significant showing consists of uranium mineralization in a screen of leucocratic metagranite surrounded by Unit 7 northeast of the 406 m lake. It was located by detailed examination of the area around a lake sediment geochemistry anomaly (McConnell, 1981). The mineralization is associated mainly with fractures in the metagranite and is widespread throughout the screen. Similar muscovite-biotite metagranite is present in screens northwest and southeast of the uranium showing and may contain additional mineral occurrences. A more detailed description of the uranium showing is given by McConnell in this report.

Taylor (personal communication) found disseminated chalcopyrite, pyrite and pyrrhotite in amphibolite dikes which crosscut metadiorite (Unit 1) west of the 452 m lake. Disseminated pyrite, pyrite veinlets and gossan are widely distributed in amphibolite south of the 452 m lake and in paragneiss and amphibolite in 13M/15.

The only mineral showing found in rocks of the Nain Igneous Complex consists of disseminated chalcopyrite, pyrrhotite and pyrite in coarse grained anorthosite situated in a stream bed east of the 452 m lake. The mineralization is very localized and consists of less than 1% total sulfides.

ACKNOWLEDGEMENTS

The writers were ably assisted in the field by B.M. Murrin, J.M. Hill and D.F. Starr. The Rb/Sr geochronology was completed under the direction of C. Brooks at the Universite de Montreal. Additional field data have been supplied by F.C. Taylor of the Geological Survey of Canada and J. McConnell of the Newfoundland Department of Mines and Energy.

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